

2D flow around a heated square-cylinder - $Re_h = 50$, $Ra = 5 \times 10^6$



A heated square-cylinder is placed in a channel flow

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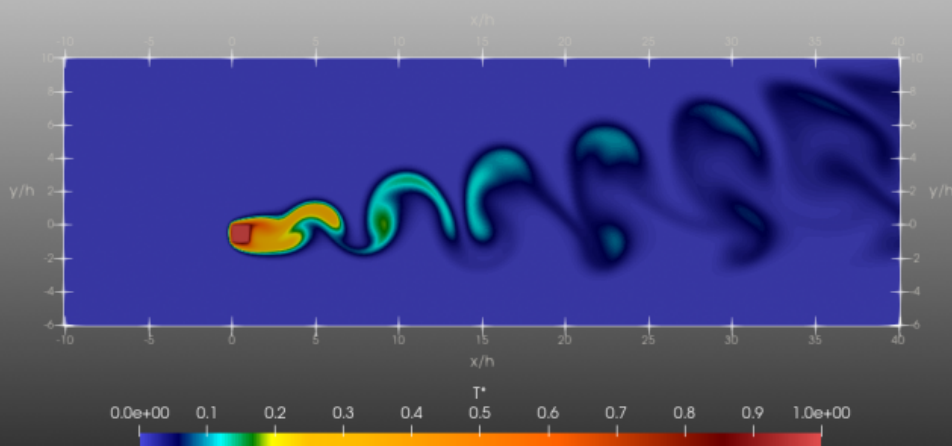
Date : June 2019

Simulation type : DNS ([Sunfluidh code](#))

Location : /DATABASE_2DFLOW_AROUND_HEATED_SQUARECYLINDER_DNS

Status : Free access

Data size : ~ 3 Gb

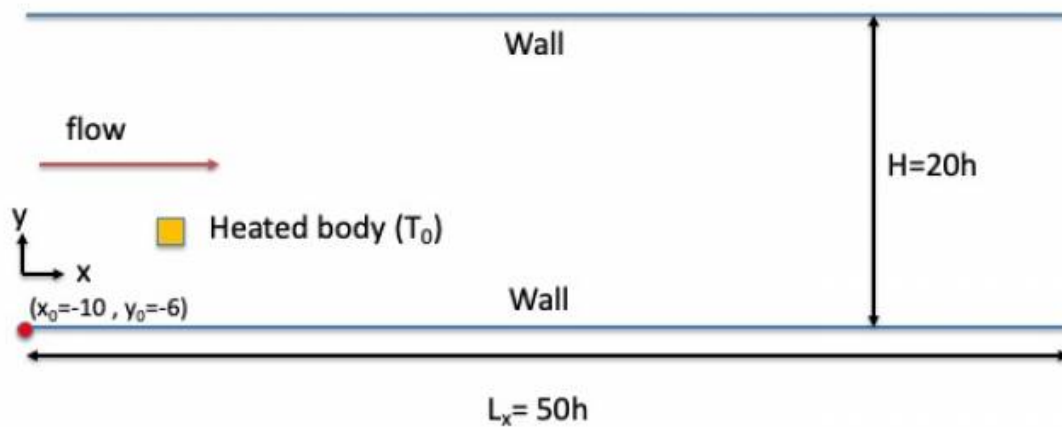


[A video is available here](#)

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Simulation settings

2D sketch



Referential : cartesian geometry

1. axes :
 - $x(i)$: downstream direction
 - $y(j)$: normal direction
2. origin : lower left corner of the computational domain
 - $x_0 = 10h$
 - $y_0 = -6h$

Reference scales

- Density : mass density of the fluid (ρ_0)
- Lengths : cylinder size (h) and $H_u = 10h$ the distance between the domain's top and the square-cylinder's top.
- Velocity : velocity at inlet (U_0)
- Dynamic viscosity : dynamic viscosity of the fluid (μ_0)
- thermal diffusivity : (κ_0)

- Reynolds number : $Re_H = \frac{\rho_0 U_0 h}{\mu_0} = 50$
- Rayleigh number : $Ra = \frac{\rho_0 \beta g \Delta T H_u^3}{\mu_0 \kappa_0} = 5 \cdot 10^6$

Non-dimensionalised data

- velocity : $U^* = \frac{U}{U_0}$
- density : $\rho^* = \frac{\rho}{\rho_0} = 1$
- coordinates : $x^* = \frac{x}{h}$, $y^* = \frac{y}{h}$
- temperature : $T^* = \frac{T - T_c}{T_h - T_c}$ (T_h and T_c are respectively the temperature imposed at the cylinder's walls and the temperature at the inlet and channel's walls)

Computational domain

1. Domain scope

- computational domain size (channel flow)
 - Downstream direction(x) : $L_x^* = 50.0$ (upward part $L_u = -10$, downward part $L_d = 40$)
 - Normal direction (y) : $H^* = 20.0$
- heated square cylinder
 - size: $h^* = 1$
 - wall temperature $T_h^* = 1$

1. Boundary conditions

- Inlet : imposed pressure uniform velocity ($U_0 = 1$)
- Outlet : Orlansky type
- Bottom and top conditions : walls at ($T_c^* = 0$)

2. Spatial resolution

- mesh size : 512×256 (131.072 cells)
- About cell-size
 - Δx^* : from 0.03125 to 0.723 (downstream direction)
 - Δy^* : from 0.03125 to 0.187 (normal direction)

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Data features

• Time series

- Physical quantities : velocity components along x and y directions (u,v) and pressure (p)
- 1 probe
- Time step = $\approx 6 \cdot 10^{-2}$ time unit (irregular time step)
- Time range : 250 time units
- Location : $X_i = 20.0$, $X_j = 2.0$
- File name (per physical quantity): $x_ins_00000.d$ with $x = u, v, t$

• 3D snapshots

- Instantaneous fields : velocity components in x, y and z directions (U,V), the pressure (P) and the phase function related to the body motion (TRACE)
- Recording rate : 1 time unit
- Time range from from 20.0 to 250.0 time units
- File name : res_XXXXX_yyyyyyy.d
 - MPI subdomain ID: from 0 to 3 (case with MPI domain decomposition)
 - Time ID : from 0 to 250

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Database organisation

Data size : ~ 3 Gb

Main directory : /vol/DATABASE_MECA/DATABASE_2DFLOW_HEATED_SQUARRECYLINDER_DNS

Directories & files

```
/DATASETUP      : ASCII files
                  input data file for sunfluidh : input3d.dat (and
input3d.dat_mpi4 for the case with MPI domain decomposition)
/GRID           : ASCII files
                  input data file           : data_meshgen.d
                  grid files for sunfluidh: maillx.d, mailly.d, maillz.d
(sequential case)
                  mesh.tar (archive containing
grid files for a domain decomposition with 4 MPI processes)
/SNAPSHOTS      : snapshots binary files res_XXXXX_yyyyyyy.d
/SNAPSHOTS_MPI4 : snapshots resulting from a domain decomposition with 4
MPI processes
/TIMESERIES     : ASCII files
                  u_ins_00000.d , v_ins_00000.d and t_ins_00000.d
(timeseries of the velocity components and temperature from probe)
```

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